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COMPARATIVE ANALYSIS OF VEHICULAR ROUTING PROTOCOL IN VANET FOR SMART CITY SCENARIO

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ABSTRACT

Vehicular ad hoc network (VANET) is an ongoing new technology similar as ad hoc network, wireless network and cellular technology to achieve inter-vehicle communications and vehicle to infrastructure communication and improve road traffic safety and efficiency. VANETs are different from other kinds of ad hoc networks by their hybrid network architectures, vehicle node movement characteristics, and new application scenarios for safety purpose. Therefore, VANETs is a unique networking research challenges, and the design of an efficient routing protocol for VANETs is very crucial. In this article, we discuss the research challenge of different routing protocol in VANETs and compared all routing protocols and distinguish efficient routing protocol for VANETs. Vehicular ad-hoc networks have recently attracted great interest in the research community, and reliable data transmission and network connectivity has become an important issue.

KEYWORDS: VANET, Routingprotocols.

1. INTRODUCTION

A new kind of vehicular Ad-Hoc network with an enormous development in technological innovations is emerging these days known as VANET (Vehicular ad hoc network). Vehicular ad hoc network (VANET) is a sub class of MANET with some unique properties. Vehicular ad hoc networks specify a new class of wireless networks that allow vehicles to communicate with each other and with roadside units. Now these days VANETs have emerging due to the need for supporting the increased number of wireless equipments that can be used in vehicles. Today VANET become a promising area of research because of their potential to provide various solutions for most of the traffic problems. VANET is a present days concept, developed as a new research area that can possible three earlier communication research area, like ad-hoc network, wireless LAN, and cellular telephony. VANET is a different from other kind of ad hoc network due to their hybrid network, architecture, vehicle mobility, battery usage, self organizing nature, distributed communication network. Previous study of vanet routing protocol mostly focused on single lane environment.

The development in the wireless technologies emerged various type of network, which provide interaction between vehicles themselves and between vehicles and road side unites. The performance of such kind of communication between vehicles depends on various routing protocol. The exchange of information between the vehicles without any fixed infrastructure such as access point or base stations is an intensive field of research in VANET. Various new concepts such as smart city and living labs are introduced in the recent years.

Therefore, in our study we focus on evaluating these protocols at different environments, i.e. low vehicles velocity, high vehicle velocity. The performance of different routing protocols has not been well measured since each researcher verifies the result with different simulation software and performance parameter for performance evaluation of results. Due previous problem in vehicle, there is continuous need to study different ad hoc routing protocols in order to select relevant routing protocols for different driving environments of VANETs.

In VANET, the routing protocols are classified into two categories: Topology based routing protocol, Position based routing protocol and Cluster based routing protocol, Geo-cast routing protocol and Broadcast routing protocol.

2. CHARACTERISTICS OF VANET

VANET has some unique characteristics which make it different from other kinds of Ad hoc networks as well as challenging for designing VANET routing protocols. VANET is an application of MANET but it has its own distinct characteristics which can be summarized as,

Fig.1 VANET Scenario

i. **Communication Environment:** VANET are typically operated on two communication environments: highway traffic environment and city environment. The node prediction design and routing algorithm also therefore need to adapt for these two environments. Highway mobility model is rather simple and easy to predict than the city mobility model. Street structure, variable node density, presence of buildings and trees that behave as obstacles to even small distance communication make the city model very complex and difficult.

ii. **High Dynamic topology:** The topology of VANET is always changing due to the high speed of vehicles and changing of path of vehicles. If we assume two vehicles moving away from each other with a speed of 60 mph (25m/sec) and the transmission range is about 250m, then the link between these two vehicles will last only for at most 10 seconds.

iii. **Frequent disconnected Network:** Due to the same reason, the nodes needed another link with nearby vehicle in about 10 seconds to maintain seamless connectivity. But in case of such failure, particularly in case of low vehicle density area, frequent disconnection of network connectivity will occur. One possible solution of such problems is addressed by road-side deployment of relay nodes.

iv. **Mobility Modelling and Prediction:** Besides the highly mobile node movement and dynamic topology, vehicular nodes are usually constrained by prebuilt highways, roads and streets. So mobility model and node prediction based on study of predefined roadways model and vehicle speed is of paramount importance for effective network protocol design for VANET.

v. **Battery Power and Storage capacity:** Modern vehicles have enough computing power because of unlimited battery power and storage which is unavailable in MANET. It is helpful for effective communication & making routing decisions.

vi. **Interaction with onboard sensors:** It is assumed that the nodes are

equipped with on-board sensors such as GPS receivers. This sensor helps in providing node position and their movement of node nature that are useful for effective communication link and routing purposes for vehicles.

3. ROUTING PROTOCOLS FOR VANET

[A] Topology-Based Routing Protocols [1]:

These topology base vanet routing protocols use in the network to perform packet forwarding mechanism. These protocols are further divided into two different groups for ad-hoc networks: Proactive and Reactive routing.

(a) Proactive Routing: Proactive routing means that routing information such as data packets continuously broadcast and flooded the data packet between nodes to maintain the route or the link between the nodes even though some of paths are not used. The benefits of the proactive routing protocols are that there is no path discovery since route to the destination is maintained in the background and is always available upon lookup. The different types of proactive routing protocols are: OLSR FSR.

(i) Fisheye State Routing (FSR): In this routing protocol each node maintains a table based routing topology on the latest data packet received from nearby nodes. The different time period for different entries in routing table to reduce the size of data packet in large networks. The disadvantage in FSR routing protocol is that the size of the routing table increases with increase in network size. Path discovery information may fail if the destination node lies out of scope of source node. Due to high node mobility in VANET, It becomes less accurate than other.

(ii) Optimized Link State Routing Protocol (OLSR): In this routing protocol every node in the network selects a number of neighbour nodes called as multipoint relays (MPR) which retransmits its packets. The neighbour nodes which are not in its MPR set can only read and process the packet.

[b] Reactive Routing: Opens the route only when it is necessary for a node to communication with each other. Reactive routings typically have a route discovery phase where query packets are flooded into the network in search of a path. The various types of reactive routing protocols are: AODV, PGB DSR and TORA.

(i) Ad-hoc On-Demand Distance Vector (AODV): Source node broadcasts a route request to its neighbours which fill forward to the destination. Then the destination unicast a route reply packet to the sender. Every node maintains broadcast-id for new RREQ, When a RREQ arrives at a node, it verify the broadcast-id, if it is less than or equal to previous message then it will discard the packet.

(ii) Temporally-Ordered Routing Algorithm (TORA): In this protocol every node constructs a directed cyclic graph by broadcasting query packets to other node. On receiving a query packet, if the node has a route to destination it will send a reply packet, else it drops the packet. It gives a route to all the nodes in the network, but the maintenance of all these routes is difficult in VANET.

(iii) Dynamic Source Routing (DSR) [8]: This protocol uses source routing instead of depending on middle node routing table. So routing overhead is always dependent on the path length. The limitation of this protocol is that the route maintenance process does not locally repair a disconnected link. The performance of the protocol rapidly decreases with increasing mobility.

(B) Position based Routing Protocols [6]:

The forwarding accord by a node is primarily based on the position of a packet destination and the position of the node one-hop neighbors. The position of the destination node is stored in the header of the packet by the source node. The position of the node's one-hop neighbors is obtained by the beacons sent periodically with random jitter to prevent collision. In other words, route is determined based on the geographic location of neighboring nodes as the packet is forwarded. There is no need of link state exchange nor route setup. Example: GPSR, VGSR

(i) Greedy Perimeter Stateless Routing (GPSR): Each node periodically broadcasts a beacon message to all its neighbors containing its id and position. If any node failed to receives any beacon message from a neighbor for a specific period of time, then GPSR router consider that the neighbor has failed or out of range, and then omits the neighbor from its table. It uses greedy forwarding decisions using information about immediate neighbors in the network. Converting network topology into planarized graph when greedy forwarding is not possible will degrade the performance of routing. The GPCR takes advantage of the fact that streets and junctions form a natural planar graph, without using any static street map.

(ii) Vertex-Based predictive Greedy Routing (VGPR): It is a multi-hop vehicle-to-infrastructure routing protocol for urban environment. The estimate sequence of valid junctions from a source node to fixed infrastructure and then, forward message to the fixed infrastructure through the series of junctions. It uses position, velocity and direction of vehicles for calculating both sequence of valid junctions and greedy forwarding. It uses predictive directional greedy routing (PDGR) to forward data from source node to the nearest fixed infrastructure. Each and every vehicle maintains a table, containing vehicle-id, position, velocity and direction of vehicles with its two-hop neighbors. The table is continuously updated by exchanging beacon messages among neighboring vehicles. VGPR have minimum control overhead, make less packet retransmissions, increases reliability of packet delivery, and reduces end to end delay.

(C) Geo-cast Based Routing Protocols:

Geo-cast routing protocols are used to send a message to all vehicular nodes in a pre-defined geographical region, it is a location based multicast routing protocol. Its aim is to deliver the packet from source node to all other nodes within a predefined geographical region.

(i) Robust Vehicular Routing (ROVER): It is a reliable geographical multicast routing protocol where only control data packets are broadcasted in the network and the data packets are unicast. The objective of the protocol is to send a message to all other vehicles within a specified Zone of Relevance. All vehicles in the ZOR are used in the routing process. It uses a reactive route discovery process within a ZOR. This protocol creates more number of redundant messages in the network which leads to congestion and more delay in packet transmission. To overcome this problem researcher proposed a Two Zone Dissemination Protocol for VANET. It uses hop-count in packet and is decremented when the packet is forwarded. If the hop-count comes to zero, the node packet will be discarded from the table. It causes nodes near to the sender forward a data multiple times. To avoid this, they introduced sequence number for every packet to detect whether a packet has been received before or not.

(D) Cluster Based Routing Protocols[10]:

Cluster-based routing protocols is preferred in clusters. Each cluster has one cluster-head, which is responsible for intra and inter-cluster management functions. Intra-cluster nodes communicate with each other using direct links, whereas inter-cluster communication is performed via cluster heads. Cluster Based Routing Protocols example: CBDRP, PBSM.

(i) Hierarchical Cluster Routing(HCR): It is a novel based Hierarchical Cluster routing protocol designed for highly mobility ad-hoc networks. HCB is two-layer communication architecture. In layer-1 mostly vehicle nodes have only one radio interface and they communicate with each other via multi-hop route. Among these vehicular nodes some other nodes also have another interface with long radio communication range called super nodes which comes in both on layer-1and layer 2. Super nodes are able to communicate with each other via the base station in layer-2, enable inter-cluster routing.

(ii) Cluster Based Location Routing (CBLR): It is a reactive and cluster based routing protocol in VANET. In cluster formation every node broadcasts a hello message and waits for a predefined time. If the node receives a reply message from a cluster head before the timer expires, it becomes a cluster member. Otherwise, it becomes a cluster head. Each cluster head maintains a chart which contains the addresses and geographic locations of the cluster members and gateways vehicular nodes, and it also maintains a Cluster Neighbors chart that contains information about the neighboring clusters. CBLR is suitable for high mobility and high density networks because it continuous updates the position of the source and destination every time before data packet transmission starts.

(E) Infrastructure Based Routing Protocols:

The following protocols are infrastructure based because the relay on fixed infrastructure for their routing. Example: SADV and RAD.

(i) Static-Node-Assisted Adaptive Data Dissemination (SADV): Is a static node assisted adaptive data dissemination protocol for vehicular ad-hoc networks. It uses static vehicular nodes at junctions to forward a packet. It employs store and forward mechanism in the static nodes till a vehicle comes into communication links or optimal path is available.

(ii) Roadside-Aided Routing (RAR): It is an effective routing in vehicular hybrid networks rather than a concrete routing protocol. Here roads are divided into different sectors by using road side units (RSUs), and the path consists of vehicles and RSUs. These protocols are not efficient in high way scenarios as they require static node or RSU.

(F) Broadcast Base Protocol [9]:

(i) Edge Aware Epidemic Protocol (EAEP): This protocol is reliable, bandwidth efficient information dissemination. The control packet reduces the protocol by eliminating exchange of additional hello packets for message transfer between different clusters of vehicles and eases cluster maintenance. Each vehicle has its own geographical position to broadcast messages to eliminate beacon messages. By receiving a new rebroadcast message, EAEP uses number of transmission from front nodes and back nodes in a given period of time to calculate the probability for making decision whether nodes will rebroadcast the message or not.

Table 1: Comparative Analysis of Routing Protocol

Parameter/protocol	Forwarding Strategy	Scenario	Infrastructure Requirement	Digital map	Recovery Strategy	Control Packet overhead
FSR	Multi hop	Urban	No	No	Multi hop	High
OLSR	Multi hop	Urban	No	No	Multi hop	High
AODV	Multi hop	Urban	No	No	Store and forward	High
TORA	Multi hop	Urban	No	No	Store and forward	Low
DSR	Multi hop	Urban	No	No	Store and forward	Low
GPSR	Greedy forwarding	Urban	No	Yes	Store and forward	Moderate
VGPR	Greedy forwarding	Urban	No	Yes	Store and forward	Moderate
ROVER	Multi hop	Urban	No	No	Flooding	High
CBRP	Multi hop	Urban	No	No	Flooding	Moderate
SADV	Greedy forwarding	High way	No	No	Store and forward	High
RAR	Multi hop	Urban	No	No	Flooding	High
HCB	Multi hop	Urban	No	Yes	Store and forward	Moderate
CBLR	Multi hop	Urban	No	Yes	Flooding	Less
EAEP	Multi hop	High way	No	No	Store and forward	High

Specifically, a node does not know whether it has missed any messages to its new neighbors or its neighbors have missed some messages. EAEP overcomes the simple flooding problem but it incurs high delay of data dissemination.

4. COMPARATIVE STUDY OF ROUTING PROTOCOL

Parameters Forwarding Routing Maintenance Scenario Strategy Recovery Infrastructure strategy Requirement Digital map Control Packet overhead No of retransmission

5. CONCLUSION

Routing is an important component in vehicle-to-vehicle (V2V) and infrastructure-to-vehicle (I2V) communication. This paper discusses various routing protocols of VANET. Designing an efficient routing protocol for all VANET applications is very hard. Hence a survey of different VANET protocols, comparing the various features is absolutely essential to come up with new proposals for VANET. The performance of VANET routing protocols depend on various parameters like mobility model, driving environment and many more. Thus this paper has come up with an exhaustive survey and comparison of different classes of VANET routing protocols. From the survey it is clear that position based, geocast and cluster based protocols are more reliable for most of the applications in VANET.

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